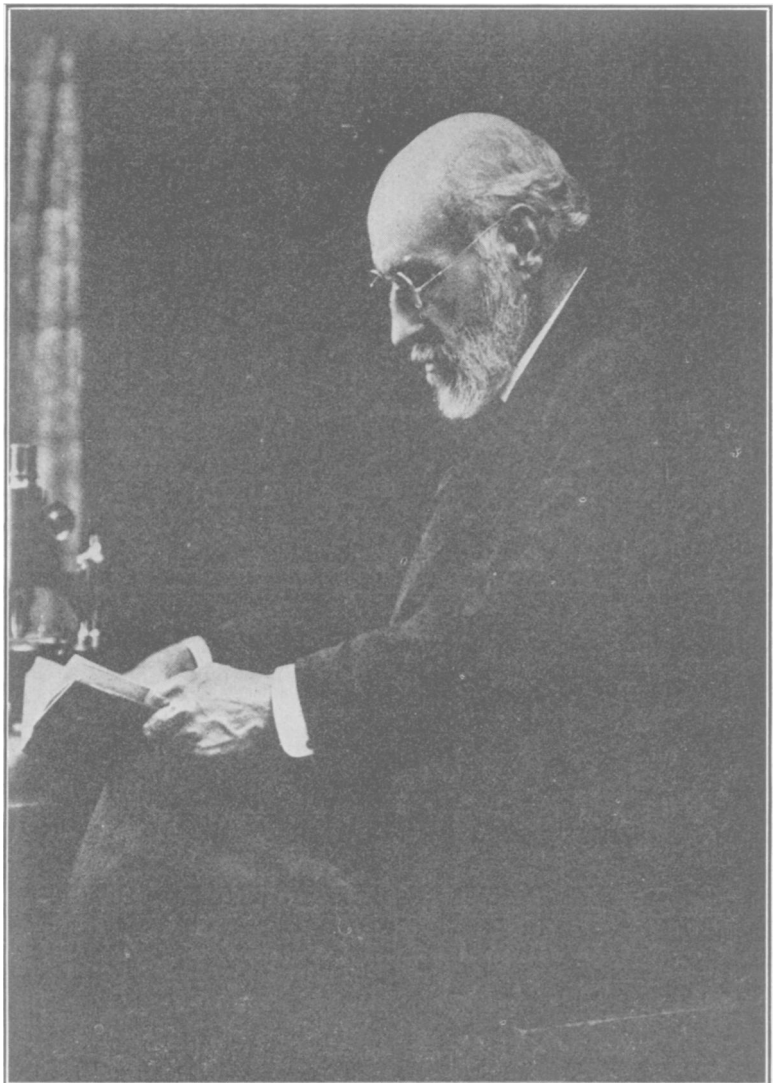

Phot. photographer, Madrid. Emery Walker ph. sc.

S. Ramon Cajal.

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EDITORIAL

RAMÓN Y CAJAL [1]

Among the outstanding figures in modern medicine, there are few whose name and fame have been established with greater unanimity of sentiment than Ramón y Cajal. His is indisputably the greatest name in Spanish medicine, both present and past, yet it was by the oddest turn of fortune that a man of such definite artistic bent came to excel in one of the most abstruse and difficult branches of science, the architectonics and finer anatomy of the central nervous system. His life-work illustrates the close affinity existing between the visualizing talent of the artist and the observational faculty of the physician.

Himself the son of an Arragonese physician at Petilla, Santiago Ramón y Cajal was born on May 1, 1852, just when the scientific trend of modern medicine had been established by Virchow, Helmholtz, Carl Ludwig and Claude Bernard. His father, a capable surgeon, was industrious, enterprising, energetic and conscientious, but through a stern struggle with poverty, a strenuous rise out of the obscure status of barber-surgeon, and the natural desire of well-meaning parents to see their offspring better off than themselves, he made the usual mistake of interfering with his son's development before the lad had really attained to the formative period and taken his stride. The mother, a mountain girl, is described as of

[1] S. Ramón y Cajal: *Recuerdos de mi vida.* 2 v. Madrid, 1907-17. 2 ed. Madrid, 1928. The recent announcement of this autobiography as a new publication, in the literary supplement of The New York Times, is erroneous.

unusual beauty, so much so, in fact, that none of the three sons and two daughters were like her. This prepotency of the male parent made for a certain monotony in the family, even to similarity in mental reactions, a genetic freak for which Cajal avows his utter distaste, since every rational person seeks what is unlike himself, does not like to see his defects duplicated in others, whence, in this case, compensation could only be sought in a different environment. From his father, however, he inherited a strong will to power, "a certain brain and muscle-producing fatality of character," ambition, tenacity of purpose and an extraordinary memory. From the very start, he was obstinate and self-willed, nearly killed in one early experience by the kick of a horse he had annoyed, constantly getting into scrapes and out of them, not unlike the young Osler, in brief, the natural, mischievous boy, as the genial Russian poet, Alexander Pushkin, depicted himself in resilient French verses:

"Vous me demandez mon portrait,
Peint d'après nature;
Mon cher, il sera bientôt fait,
Quoiqu'en miniature.

Je suis un jeune polisson,
Encore dans les classes;
Point sot, je le dis sans façons,
Et sans fades grimaces.

Vrai démon par l'espièglerie,
Vrai singe par sa mine,
Beaucoup et trop d'étourderie
Ma foi! voilà Pouchkine."

Point sot, in effect, so determined was young Cajal to follow his own inclination, so irksome did he find coercion and criticism, that even as a lad, he came to extol the advantages of solitude. His reasoning on this head is worth considering. Even when personal fellowships and friendships are established in the world, he says, solitude is preferable to society, as engendering ideas and permitting their serene development, while "conversation" is usually a monologue maintained on two sides, in which one's

own lines of thought may be interrupted by the verbiage, egotism and personal vivacity of others, to the abasement of intelligence, the weakening of will power and sterilization of effort up to the point of rendering it impossible. Except when deliberately cultivated by *cognoscenti* as a fine art, "there is no conversation." Wisdom lies, not in avoiding activity or society, but in choosing lines of activity and social relations which are conformable to one's ultimate nature. And this self-evident principle Cajal, a great frequenter of clubs, observed throughout his life. A natural bird fancier and ornithologist—for an aviary is a kind of fixture in a Spanish home—he devoted much of his childhood to the collection of birds and birds' eggs. When, later, an artistic bent asserted itself, he found another outlet in wholesale sketching, to the disgust of his over-anxious parent. Three events of his schooldays made a profound impression upon him. A commemoration of Spanish victories in Africa gave him a sense of patriotism and national solidarity, as one way of overleaping the narrow confines of family and small town pettiness, to identify himself with larger social aims. A sudden stroke of lightning during prayers in school, killed the good priest about to ring the bell in an adjoining belfry, knocked senseless the devout schoolmistress, all but capsized his own faith in the workings of a divine providence, confirmed his natural bent to irony and pessimism and left him with an abiding perception of the helplessness of man in the face of the blind, cruel, unjust force which is Nature. On top of this, the eclipse of the sun in 1860, raised the question: Can science predict a happening millions of miles away, yet remain impotent before a stroke of lightning? His education had begun at four, and all this came before the age of eight. Shortly after, his parents moved to Ayerbe, where he found himself assaulted with sticks and stones by the boys in the city square, "through the natural hatred of natives for the stranger or of yokelry for the city-bred, even if a child." With these new boys, however, he was soon in *rapport* and ringleader in such pranks as breaking lamps, robbing orchards and mocking the elderly. He de-

veloped, in fact, a rude science of ballistics and later wrote a small treatise on "lapidary strategy." His talent for drawing revealing itself about this time, he came into definite conflict with his father, whose nature had been warped and embittered by fear of poverty (resulting from his own experiences with overwork and chill penury) and a tendency to *brutaliser la machine.* A malicious painter had observed of young Cajal's drawings: *"El chico scrà jamàs un artista."*

Thus, determined to make the boy a doctor, the father packed him off to school at Jaca, a kind of Dotheboys Hall, where he was flogged for his stubbornness by a bigoted *padre* and purposely starved to such an extent that, at the end of five months of it, he was brought home "a living skeleton, like a phthisical patient in the last stage of inanition." It is to the credit of Cajal that he takes no mealy-mouthed line about all this. His resentment is as definite and implacable at sixty as at the age of ten and outlined with Latin precision. It is a sad rule of life, he thinks, that sacrifices the bloom and cheerfulness of youth to the musty precepts of a mean old age, and nothing whatever is gained by it. If a natural boy is all volition, like an Indian brave, an inevitable anarchist and communist, despising the weak, how can he get to love knowledge or wisdom any more than men, if the tranquility necessary to acquire it is destroyed by blows and starving? Furthermore, he notes, your smart memorizing boys reveal but a meagre talent for science when put to a real test. Convalescing quickly, his revenge was to construct a wooden cannon, which not only went off but did so much damage to property that he was jailed for three days by the local *alcalde*, at his father's instance, in a filthy cell, where he became intimate with fleas, lice, *Aspergillus niger* and *Blatta orientalis* and again deprived of food, would have starved but for the viands slipped through the bars by a stealthy compassionate lady. He very properly threatened to throw rocks through these bars at people who collected about the jail to gape at his discomfiture. Next year, he was sent to school at Huesca and fared no better.

His father wanted him to become proficient in dead languages, to acquire elegance and amenity, because he himself lacked them, reasoning narrowly that the authority and prestige of the embryo doctor were to derive, not from his science and social gifts, but from a reputation for character and erudition, *i. e.,* from the very things a really efficient physician might dispense with on occasion. The public, Cajal opines, is usually ignorant that talent is in inverse ratio to character, or that solid ability varies inversely with sterile pedantry, so that a doctor in Spain is apt to be judged by his façade and general culture rather than by his actual professional skill. Teachers of boys, he says, should not be oldish pedantic men, tending toward second childhood, but sufficiently young and vigorous to be in sympathy with them and command their respect. Boys of ten to fourteen cannot ordinarily understand languages and mathematics but prefer subjects like astronomy, geography or history. At Huesca, Cajal was bullied and beaten by bigger boys, who incurred his resentment by making fun of his overcoat, and on one occasion, deserted him *en masse,* when he was drowning under the thick ice of a skating pond, from which he extricated himself with difficulty. He was twice chased and beaten by watchmen for stealing roses from gardens, in one case taking refuge in a tree, in the other tumbling into a mud-hole. All this led him to cultivate gymnastics extensively, as a defensive reaction, but his natural propensity to ridicule pedantry again got him into hot water with his schoolmasters and at thirteen he was actually apprenticed in succession to a barber and to sundry shoemakers of the locality. After a year's experience with shoemaking, in which he learned to fashion the daintiest feminine footgear, he was again put to school at Huesca, this time to study "science" and with permission to take lessons in drawing. But he found rhetoric and eloquence more prized than realistic perception of fact, was stupefied by the innumerable philosophical systems and the jargon of psychology, caricatured his professors on a wall with dire results, tried to run away, and was at length taken in hand by his father himself, who

now began to drill him personally in osteology, even taking a hand in robbing ossuaries for this purpose. To these modest lessons on human bones, Cajal attributes his ultimate development into a morphologist. Here his talent for drawing was employed to such good purpose that his father attempted to publish an anatomic atlas of his son's colored sketches, a project frustrated by the backward condition of the graphic arts in Spain. Going up to Zaragoza to complete his medical studies, and where his parent was ultimately established as prosector, he encountered some remarkable medical professors. One of them, holding the chair of pathology, admitted that he knew no chemistry, but advised his students to follow it, as the future key to his science. Another was so old that he sometimes forgot his false teeth, and so found himself inarticulate. This, to his relief, was the signal for a spontaneous exodus of the students. A third, holding the chair of obstetrics, was completely taken in when Cajal jr., in a quiz, gave a brilliant crayon demonstration of the membranes of the embryo at the blackboard, although "a question about fœtal presentations or positions would have floored him as an ignoramus."

Some of these men were of superior character but intellectually of more provincial stamp than the medical leaders of the Corte. With Don Manuel Daina, a pupil of Nélaton and Velpeau and incumbent of the chair of anatomy and pathology, Cajal was a prime favorite and, without being particularly brilliant, got his medical degree in 1873. Meanwhile, he had the usual youthful fling at dabbling in poetry, romance and philosophy. By graduation, he was a finished athlete, trying conclusions with school bullies and easily victorious in a fist-fight over a local "Venus de Milo," a young woman of great wealth and of the "cool blonde" temperament, who lived and died indifferent to and unconscious of the turmoil she had created among hot blooded, callow students.

His athletic build, along with his great skill in dissecting, proved helpful to Cajal in passing an examination

for admission to the Medical Corps of the Spanish Army, a step taken in consequence of Castelar's revival of obligatory military service. Resplendent in a "flaming uniform," he was ordered to join his regiment at Burgos, to participate in a campaign against the Carlists at Lerida. After marching and countermarching with his command for eight months, the apparent intention being to annoy the enemy without coming into contact with him, he was promoted to a captaincy and ordered to Cuba. Against the wishes of his father, and under the spell of St. Pierre (*Paul and Virginia*) and Chateaubriand (*Atala*), he sailed in April, 1874, to discover that the primeval forest of his dreams was a fraud—gloomy, dolorous and "uninhabitable by man." There was no *bosqué milenario,* only thickets of scrubby growth; the animal life was mediocre and confined to parrots and colibris. The Cuban he defines as the Andalusian over again, in speech, natural grace, languid *finesse* and "Creole mentality." Ethnic beauty was best preserved in the women, whom he describes as "sweet and suave to a degree unknown in Europe." While he holds it a tactical political blunder to have colonized the island with other stock than the hardy Arragonese and Navarrese of the North, yet he maintains that the white race is nonresistant to the tropics, of which view he (an Arragonese) was presently to have bitter and memorable experience. Neglecting to use his father's letters of recommendation or other push and pull, he was assigned, not to one of the coveted hospital or mobile battalion details, but to an isolated, poorly appointed and unhealthy infirmary of 200 beds, filled with patients, in the thicket at Vista Hermosa, near Puerto Principe, and was soon down with paludism and dysentery. After sticking it out for four months, he was allowed to convalesce in Puerto Principe, with 1½ months service in the local military hospital. The military pharmacist having decamped to the United States with 90,000 pesos in funds, Cajal got his pay but once and had to borrow from his comrades, who raised the amount grudgingly. Being Republican just at the Restoration, when the whole army was Alphonsine, he was not overly influ-

ential and was presently ordered to the hospital at San Isidro, on the military road in the East, which, in his physical condition, proved a worse station than the other. By the spring of 1875, when he got his resignation accepted, Cajal was a very sick man. Improved by the sea voyage and some residence in the North, he returned to Zaragoza, took a medical degree in Madrid, became assistant demonstrator at Zaragoza, where he acquired a micrographic laboratory and eventually the chair in anatomy (1877) and the directorship of the Anatomical Museum (1879). Here his youthful period ends,[2] and the less eventful course of his scientific career begins. In 1878, he sustained a grave hemoptysis, merging rapidly into pulmonary tuberculosis, which necessitated a long course of outdoor sunlight treatment, instituted by his father (a very good doctor) at the baths of Panticosa and in the pine boscage on the summit of Monte Pano. Yet in 1879, against the advice of everybody, and on a monthly income of 25 duros and a few private fees, he married. His account of this episode illustrates his straightforward simplicity and candor:

"Returning one evening from a walk to Torrero, I encountered a young girl of modest appearance, accompanied by her mother. Her blushing, springlike face suggested Raphael's madonnas, or better still, a German colored engraving of Marguerite in Faust. Attracted no doubt by the sweet, pleasant disposition apparent in her features, her slender figure, her large green eyes veiled by long lashes, her abundant hair, I was even more impressed by the air of childlike innocence and melancholy resignation which emanated from her whole being. Unseen, I followed the young girl to her home, learned that she was the orphaned daughter of a modest employee and enjoyed a reputation for honor, modesty and domestic tastes. I made her acquaintance and after a time, against the collective advice of my family, married her, not without due consideration of the mental characteristics of my fiancée, which were complementary to my own. My resolution was discussed by acquaintances in clubs and cafés as an act of madness: Poor Ramón is lost forever. Good-bye to study, science and generous ambitions. . . . And yet, although eulogies do not flow readily from my pen, I take pleasure in saying that, with beauty which seemed predestined to shine in promenades, visits and receptions, my wife cheerfully

[2] The engaging boyhood chapters of Cajal's autobiography have been issued in this country as a Spanish reader for students (*La infancia de Ramón y Cajal,* New York, 1925).

condemned herself to the obscurity of my lot, remaining simple in her tastes and with no other aspirations than tranquil contentment, order and system in the management of the home, and the happiness of her husband and children."

In January, 1884, Cajal was called to the chair of anatomy at Valencia, at a monthly salary of 52 duros (3500 pesetas annually). Here the cholera epidemic of 1885 soon drew him into the question of Ferran's vaccines, concerning which he was directed to render a report by the Central Committee. While the first in Spain to establish the causal relation of the Koch (comma) bacillus by a staining method of his own, and to demonstrate the possibility of immunization with dead cultures, his reaction to the Ferran vaccines was negative. Independently of Pfeiffer, he showed that the comma bacillus, while harmless in subcutaneous injections, proves highly toxic to the peritoneum of the guinea pig; but he reasoned that it would be necessary to find a mammal cholerizable *per os* yet capable of resisting intestinal infection through previous subcutaneous vaccination with a pure or attenuated culture. Such an animal, he says was not to be found. Further investigations on degenerative processes in the protoplasm of the comma bacillus, and the gift of a fine Zeiss microscope by the Central Committee, opened out the prospect of fame and fortune in the new and lucrative arena of bacteriology. But economic considerations and an ingrained love of privacy availed to confirm Cajal in his original choice—a career of relative poverty within the restricted terrain of his chosen discipline. In either alternative, his future lay under the microscope. For the world of the infinitely little, he was better visioned and consequently had better luck from the start than most investigators, and here, his artistic skill with pencil and brush, subsequently helped out by the photo-lithographic processes and staining devices of his invention, was to prove a powerful aid, undreamed of by his parent. His earlier investigations in histology, illustrated by himself, fell flat and were first made known to continental Europe by

Krause of Göttingen and by the generous Kölliker (Würzburg), who may be said to have done most for the initial reputations of both Röntgen and Ramón y Cajal.

Through Dr. Luis Simarra, a neuro-psychiatrist of Madrid, Cajal learned the use of Golgi's chrome silver stain (1880-85), an elusive method which he improved by a fixation process and applied to the entire nervous system in a way to incur the lasting intransigence of the Pavian professor. Work on the finer anatomy of the nervous system began with Cajal's transfer to the Barcelona chair (1887) and was at first received with the utmost skepticism. Simarra himself had abandoned the tricky Golgi stain, and eventually wrote to Cajal in 1889 that its results were "more suggestive than demonstrative." In the same year, after a period of great productivity, Cajal went up to Berlin to demonstrate his results to the Anatomische Gesellschaft. Kölliker, Retzius, His, Waldeyer, van Gehuchten, Bardeleben, Schwalbe were all politely skeptical, had indeed got nothing from the new stain but deceptive results amounting to failure, until Cajal, in halting French, demonstrated his slides and showed them how to use it. His results were then confirmed by Kölliker and others. Cajal's reputation was now made, and his transfer to Madrid in 1892 followed as a matter of course. Once domiciled in the Corte, he soon found that arduous investigation was incompatible with the social distractions of a large city, but most of his colleagues being of the same mind (*nadie hacia casa de nadie*), he was able to isolate himself, with only a casual reputation for top-heavy eccentricity. He found solace in promenades about the beautiful environs of Madrid, of which he claims to some extent the discovery, and the clubs. In these, he found pleasant relations, first with the old military comrades of his Cuban period, who soon bored him by continual soreness about pay, promotions and superiors; later with Calleja, Oloriz, San Martin, Letamendi, Gomez Ocaña and other brilliant men of the Madrid Faculty, of whom he gives a series of discriminating pen-portraits. In 1894, Sir Michael Foster invited Cajal to deliver the Croonian Lecture before the Royal

Society of London, where he was stirred with admiration for the magnitude of English scientific institutions. Saddened by the disaster of the Spanish American War, the results of which were foreseen by Sagasta, Moret and Canalejas, he was surprised by an invitation to participate at the decennial celebration at Clark University (three lectures) in the following year (1899). Consenting reluctantly, he had a few negligible experiences with reporters, Fourth of July noises, a secretary who spoiled an irreproachable frock-coat by hoisting the Cajal baggage (90 kilos) into a conveyance, under the pretext that "in democracy" such solemn nonsense constituted the duty "not of servants but of every citizen"; and a host who told Cajal that "only Spanish women were talented and he himself the only living Spaniard endowed with common sense"; but, apart from a few other specimens of post-bellum asininity and bumptiousness, he was very agreeably impressed. At this time, Cajal was a handsome figure, with the abstracted mien of a laboratory worker, in the prime of life and of international reputation. In 1900, he was awarded the "Moscow Prize" at the International Medical Congress (Paris), and had already gained the Rubio, Fauvelle and Martinez Molina prizes. In 1903, his *Laboratorio de investigaciones biologicas,* authorized by the Cortes in 1901 and now known as the Instituto Cajal was completed. He received the Helmholtz medal of the Royal Prussian Academy (1904) and, in 1906, was summoned to Stockholm to receive the Nobel Prize, conjointly with Golgi. This event was spoiled for Cajal by the pompous and tedious self-reference of his fellow-prizeman, who, impressive with Victor Emmanuel moustaches, took all the credit to himself for the neuron theory and the finer anatomy of the nerve-centres, to the consternation of the courteous Retzius and other eminent colleagues. In the same year, Moret offered Cajal the Ministry of Public Instruction, which he very wisely declined. In 1913-14, he crowned his scientific career by the publication of his great work on degeneration and regeneration of the nervous system, printed at the expense of Spanish physicians in Argentina, and reissued

by the Oxford University Press in English translation in 1928. His laboratory became known as the Instituto Cajal upon his retirement in 1922.

The scientific achievement of Cajal is impressive, both as to quality and quantity. From the *Spieltrieb* of the natural, careless boy, "sure of his dinner," there evolved, as in Osler's case, a man of prodigious industry, whose main object in middle life was to economize time for the prosecution of work in his chosen field. At the start, Cajal noted that nearly every finding in histology is incomplete, a mere first stage, needing further development and elucidation, so that much of his work has been of detailed character, often concerned with improvement or confutation of the findings of others. Hence he was frequently enmeshed in controversy and, doubtless in consequence of neglect resulting from the barrier of language, has been overly meticulous in setting forth the minutiæ of his labors. A proper perspective of the woods is sometimes difficult to obtain from proximity of the trees, for in neurological histology, things frankly negligible on the broad current of medicine become of portentous significance. The second volume of his memoirs (1917), a stout, heavy volume of 615 pages, is mainly taken up with these complex details. Estimate of the extent and magnitude of Cajal's achievement may perhaps be sensed from the following chronological tabulation, condensed from his own "telegraphic" summaries:

1880. Investigations on the genesis of inflammation.

1881. On the nerve endings of voluntary muscle in the frog.

1885. On the comma bacillus of cholera.
On involutional and monster forms of the cholera bacillus.

1886. Study of anastomosing cells of stratified pavement epithelium.

1887. Histology and staining of the cortex of bone.
Texture of mammalian muscle fibre.
Muscles of the paws of insects.
Plasmatic conduits in hyaline cartilage.

1888. Texture of muscle fibres of paws and wings of insects.
Improvement of Golgi stain.
Discovery of the varied forms of terminal and collateral ramifications of the axis cylinder, their contact with the nerve cells and

dendrites, the rôle of the soma and offshoots of nerve cells as conducting chains, and the conduction of nervous impulse by contact or induction.

1889. Publishes *Manual of Histology and Micrographic Technics.* 6 ed. 1914.

1889-90. Studies on the histology of the spinal cord; description of the collaterals of white substance, the formation of commissure-fibres, classification of the neurons of the gray matter; T and V-shaped forkings in ascending and descending fibres of the two lateral columns; existence of innumerable small neurons in the Rolandic substance; the terminal *anlage* of sensory roots in birds and mammals; confirmation of views of His on the origin of the posterior roots from sensory ganglia; structure of the visual lobules of birds.

1890. *Manual of Pathological Anatomy.* 5 ed. 1913.

Studies in neurogeny (embryology of neurons and nerves, cells and fibres of the cerebellar cortex, including metamorphoses in Purkinje and granule cells).

Discovery of network of nerve-cells around fascicles of striated muscle in insects.

Sympathetic nerve-endings in heart of reptiles and batrachians; minutiae in histology of cerebral cortex and olfactory bulb.

Controversy with Golgi as to discovery of collateral fibres in spinal cord (1880).

1891. Pyramidal ("psychic") cells in cerebral cortex of reptiles, birds and mammals.

Minutiae in histology of neurons in brain, terminal sympathetic fibres, and retina.

Theory of dynamic polarisation of neurons (transmission of nerve impulse from receptor (soma and prolongations) *via* axon to distributor (end ramifications); modified 1897, as Theory of Axopetal Polarization).

Popular lectures on structure of nervous system at Barcelona. (French translation by Mathias Duval, 1894.)

1892. Monograph on retina of vertebrates (*La Cellule,* ix. no. 1; German translation by Richard Greeff, 1894).

1892-3. Structure of horn of Ammon. (Translation by Kölliker, 1893.)

1893. Histology of intestinal sympathetic.

1894. Croonian lecture on finer anatomy of nerve centers. (Royal Society of London).

1894-6. Histology of pons Varolii, hypophysis, auditory nerve, corpus striatum.

1896. New structural findings in retina.

Structure of epithelial tumors (use of triple stain).

New findings in central nervous system; morphology of nerve-cell and neuroglia.

1897. Theory of Axopetal Polarization of Neuron (1891).
Publishes Elements of Histology. 7 ed. 1921.
Discourse on *Rules and Wrinkles in Biological Investigation.*
Speculations on histologic mechanism of association, ideation and attention, (avalanche transmission of peripheral sensation from dendrites to nerve centres).
Dynamics of neuron (Economy of space, matter and time in transmission of impulse).
Starts *Revista trimestral micrográphica.*

1897-1904. Publishes 3 volume treatise on *Texture of the Nervous System.* (French translation by L. Azoulay, 1909-11.)

1898. Structure of optic chiasm; general theory of decussation.

1899. Three lectures on cerebral cortex at Clark University.

1899-1900. Structure of Flechsig projection (perceptive) centers, visual, auditory and olfactory centers, island of Reil (histologic mechanism of localisation of function). (German translation by J. Bresler, 1900).

1900. Appointed director of Instituto nacional de higiene de Alfonso XIII (Madrid).

1900-01. Histology of auditory and cochlear nerves, thalamus, olfactory centre, nucleus of corpora quadrigemina.

1902-03. Structure of septum lucidum, thalamus, cerebellum.

1903. Acquires Laboratorio de investigaciones biologicas (Instituto *Cajal*).
Revista trimestral micrographia becomes *Trabajos del Laboratorio de investigaciones biologicas.*
New method of staining nerve cells and fibres (silver nitrate and pyrogallic acid), structure of neurofibrillae; Golgi reticulum; embryology of cerebral nerves, spinal ganglia, motor end-plates, etc.

1905. Histology of sensory and sympathetic ganglia in man and mammals (use of modified silver stain).

1905-6. Mechanism of regeneration. Origin of nerve-fibres and neuron.

1907. Controversies with Held (neuroblasts) and Apathy (neurofibrillar continuity).

1908-9. Comparative histology of cerebellum, medulla, auditory ganglia; origins and endings of sensory and motor nerves.

1910-12. Degeneration and regeneration of neurons and axons of central nervous system; non-regenerability of central paths; structure nucleus of nerve-cells; autolysis and extravital culture of neurons; neurotropism; transplantation of nerves and ganglia; staining of blood platelets.

1912. Treatise on Colored Photography.

1912-13. Staining of Golgi reticulum with uranium nitrate.

1913. Studies of neuroglia with new gold-sublimate (elective) stain: "third element" of the central nervous system (small bodies around neurons without dendrites).

1913-14. Monograph on *Degeneration and Regeneration of the Nervous System* (English translation, 1928).

1915. *Anlage* of retina in insects (pathways of transmission of nerve-impulse).

1916. Gold-sublimate stain for neuroglia (1913): improvement of technique.

1917. Retina and visual centers of Cephalopoda.

1918. Stereoscopic and bi-planar photomicrography of nerve-tissue. Structure of ocelli and their nerves in insects. *Technical Manual of Pathological Anatomy* (with Tello).

1920. Modification of Bielschowsky method of staining neuroglia and mesoglia; "third element" described as "dwarf satellites" of neurons; mesoglia cells of cerebellum.

1921. Method of silver impregnation for cerebellar sections; visual cortex of cat; studies of sensation in ants.

1922. Typical finer anatomy of regional cortex of rodents (1893). Retirement. Foundation of Instituto Cajal.

It was the youthful ambition of Cajal to found no less than a school of Spanish histologists, at that time seemingly the most Quixotic project ever entertained in the medical history of his nation. Yet he succeeded magnificently. His pupils include such men as the eminent neuropsychiatrist Nicolas Achucarro (1851-1918), who worked on the neuroglia and devised a new stain for connective tissues generally, Pio del Rio Hortega, who discovered the microglia and oligodendria cells (1919), and Francisco Tello, who succeeded Cajal in the Madrid chair of histology and is remarkable for his investigations of the neurofibrillae, transplantation of cerebral nerves, development and regeneration of nerve endings. Among the more recent men, de Castro (neuroglia, sympathetic ganglia), Villaverde (neuropathology), Sanchez (comparative neurohistology) and Llorente de Nó (auditory and vestibular nerves), have already made their mark. Cajal himself will always be memorable as the prime mover of improved staining methods which enabled him to elucidate the minute details of the finer anatomy of all parts of the nervous system on a scale never before realized. His actual con-

tribution is the ultimate developmental and structural basis of the dynamics of the neuron, of transmission of impulse, of localization of function, of degeneration and regeneration of the neurons and axons of the nerve-centers. His great memoir on the histology of the retina (1892), completes and supplements the pioneer investigation of Max Schultze (1866). His encyclopedic treatises on neuro-histology (1897-1904) and on degeneration and regeneration in the nervous system (1913-14) are his masterpieces. The tendency of the latter is confirmation of the Wallerian law of degeneration (continuity of neuroblastic and primary axones) all along the line. Few have better realized the very human tendency of scientific men to flock, in warlike array, to the standards of their respective nations, their chosen leaders or pet hypotheses on occasion, and the equally human tendency of leaders to demand unquestioned fealty of their vassals, even to the extent of suppressing data which do not square with their theories, lest a beautiful hypothesis be slain by a nasty, incontrovertible little fact. Cajal has shown a rare and noble gratitude toward the men who first made his European reputation possible by confirming his results, and like Charcot, he has not only reciprocated handsomely but has been more conscientious than most in according due credit to the work of foreign investigators. His footnote references and bibliographies are complete, scholarly and accurate. At Stockholm, in contrast with Golgi, he enlarged, with generous profusion, upon the work of the men who had initiated, confirmed and supplemented his own endeavors. The life-long intransigence of Golgi, puzzled him, in fact, and the entry of the two as *primi inter pares,* with reference to the Nobel Prize, was perhaps an unintentional tactical blunder. To "solder incompatibles and make them kiss" is a favorite humorous device of organized social and scientific meetings, where the impersonal aims of science might be better attained by the ordinary pharmaceutic plan of keeping them apart. On such occasions, a Lobachevskian devil's advocate has been known

to mutter: "Cursed are the peacemakers, for theirs is the kingdom of Dis and discord, the hotbed of future wars."

There was in Cajal the making of a philosopher as well as of the artist and the anatomist, as shown by his boyhood reactions to important happenings in his life. His purely literary performances include his autobiography (1901-17), some "pseudo-scientific" vacation stories (1905), a discourse on the centenary of the publication of Don Quixote (1905) and *Charlas de Café,* a string of anecdotes, aphorisms and philosophical observations, sombre in tendency, but some of them finished works of art, suggesting Chamfort, Stendhal, Schopenhauer, Nietzsche and the other masters of tabloid cynicism. The Autobiography is of unequal merit, eminently readable in the first volume, unwieldy and unmanageable in the second, by reason of the portentous inclusion of scientific material. The utterances are those of a terrible truth-teller, downright, forthright, from the shoulder, "uncompromising as justice," yet imbued with that fine Latin quality of good taste, which instinctively evades crudity as well as cant. Aside from the trite observation that old age begins with decline of the generative powers, little is said about the sexual, nor is any extravagant line taken with reference to politics or religion. The author is concerned mainly with the personal merits and failings of the featherless biped which is man. A liberal in politics, yet rendering unto Caesar that which is Caesar's, Cajal has perhaps reflected more credit and honor upon his country than any other man save Cervantes or Velasquez or Calderon Barca; his criticisms of its shortcomings are tempered with the sadness of comprehending sympathy. Spain, he says, has art and letters but no science. In his view, Spain was ruined, not by punctilios about "honor," but by the overweening ambitions of the House of Austria, which, using religion as a stalking horse, squandered blood and money on false dynastic interests which concerned Spaniards not at all. Here the analogy with the baleful reputation acquired by Prussia and Russia from the same trend is strong, yet with all due censure of the men higher up, some blame must be

accorded to participants lower down, and in the Autobiography, one senses the curious contrasts of *bonhomie* and barbarity in Spanish character which are in all races and nations. Cajal himself combines the expansive idealism of Calderon with the mundane irony of Gracian or Quevedo Villegas—a prose Shelley with a touch of Chamfort.

Says George Brandes: "The great pessimistic Latin writers, such as Flaubert or Leopardi, are stylists in harsh, firm outlines: German sadness is glaringly humorous or pathetic or sentimental; the melancholy of the Slavs springs from their weakness and sorrow, coming in a direct line from the sadness of the Slavic popular ballads." The sentences from *Charlas de Café* translated below must be judged from some such angle. The observation of life is as direct, mordant and uncompromising as that of Dante or Chamfort or Tirso de Molina. All is suffused with the Latin pessimism, but there is about Cajal the comprehending vision and compassion of the greater physicians and a grace of expression which bespeaks the natural artist. Not every aphorism is as successful as the *"El mundo es poco"* of Columbus or those sentences of La Rouchefoucauld which are greater individual contributions to literature than the same number of stodgy volumes by duller men; but here, as "mere literature," we have Ramón y Cajal at his best; here he attains to what Renan styles, the highest gift of man, "the art of being essentially impersonal," bidding us farewell with the gesture of the noble Spanish poet—

"Asi, Cipriano, son
Todas las glorias de ese mundo."

Sentences from Charlas de Cafe

(Translated by F. H. Garrison and printed by kind permission of the distinguished author.)

The most effective and economical of all reactions to injury is silence.

Never become intimate with the friends of your enemies; they are spies, reporting upon your errors and defects.

The ingrate, who deserts us after a benefit received, is preferable to the kind of gratitude that buttonholes us for all tribulations thereafter.

It is best to attenuate the virulence of our adversaries with the chloroform of courtesy and flattery, much as bacteriologists disarm a pathogen by converting it into a vaccine.

If you wish to be independent, admit no one outside your family to the familiarity which tyrants display to their vassals.

To pardon the first grave deception in children, servants or friends is to be victimized by the last one.

The joviality of friends is the best antidote for the venom of the world and the fatigues of life. In the words of the old song: "He loves me who makes me laugh."

Man is an illogical animal, whose reactions correspond less with his sentiments than with his interests.

There are painful and implacable hatreds which have no other origin than a certain distraction upon being spoken to or one's forgetfulness to acknowledge a card.

A. I see that you are good friends. B. Not exactly; we are useful to each other.

Beauty is a letter of credit signed by God and often directed into false channels by the Devil.

Nature offered women chastity to make them strong and sane.

A beautiful woman is always preferable to an eccentric one.

The assimilation of women to the masculine physique and mentality will, I fear, convert the angel of the hearth into an antipathetic virago, while love will transform itself into an onerous public duty to produce laborers and soldiers.

In Northern countries, manly beauty is usually superior to the feminine, by contrast with the feminine superiority of the South.

How many lovers and husbands are now devoured by their loved ones!

Matrimony out of compassion is the most refined mode of egotism.

All matrimonial shipwrecks come from the fact that the wife did not select but was selected.

In youth we say: "I am immortal." In age, we say: "I die without having lived." And it would be the same if we lived the three hundred years of the crocodile or the two hundred of the elephant.

Gray matter abounds in countries with gray skies.

Like the cordilleras, which seem more distant on cloudy days than in clear sunshine, certain minds envelop themselves in clouds to seem profound.

Genius, like the inhabitants of the depths of the sea, moves by its own light.

Truth is a corrosive acid which is sure to bespatter him who handles it.

It is difficult to be a friend to one's friends without being an enemy of justice.

Take care when an adversary does you justice in public; in that case, you need it.

People are neither good nor bad but spiritless, distracted, lazy and generally tardy or forgetful of duty.

The highest happiness almost always coincides with forgetfulness of ourselves and of others. This beatific alienation of frivolous or disagreeable things is attained when we ask our servant: Have I eaten?—an unequivocal criterion of vocation.

Every gratuitous burden of responsibility is essentially immoral.

A woman venerates her parents, esteems her husband but adores only her sons.

Aristocracies are like the lighter and more tenuous gases of the higher atmosphere, of invincible inertia and incapable of combining with active, useful elements.

When I clapped for the waiter in a café, it was greeted by the wretched pianist as applause.

The increase of unpunished crimes goes to show that men are good or mediocre from apathy, lassitude or inconscience and that laws appear to have been dictated *ex profeso* against those who ignore them.

We disdain and hate from lack of self-comprehension and we understand in proportion as we study ourselves.

Try to honor your children lest they dishonor you.

Civilization, like life itself, arose on the seashore.

Injustice would not be so fearful were it not more audacious and diligent than justice. The first collects, the other pays.

At the bottom of the anxiety for immortality lies the frantic desire to get away from the world and from ourselves.

Vitalists are like the Chinese, who maintained that Prince Borghese's automobile was propelled by a horse inside.

Truth is as modest and obdurate as an honest woman, who might give herself to a well bred, youthful lover but never to a clique of conceited old goats.

Those who have not been a little wild in youth are in danger of being so in age, excepting always the mentally defective, the weak-willed and the prematurely old.

Rhetorical emphasis, like the florid, polychrome Manila shawl, does not favor beauty but italicizes vulgarity.

Do you wish to be invisible to men? Be poor. To women? Be old.

To the heroic virgins who marry old goats, the X-rays disclose only skeletons, purses and diamonds, which they view without dismay as harbingers of a succulent and diverting widowhood.

Towers of ivory may become lonely towers of silence.

The *homo homini lupus* of Hobbes is a libel on Br'er Wolf,[3] who kills

[3] "Brother Wolf" is the expression both of St. Francis of Assisi and of Uncle Remus.

only to satisfy his hunger and does not formulate cynical theories to justify his crimes.

To be right before the right time is heresy which is sometimes paid for by martyrdom.

If business is "other people's money," then power and happiness are other people's misery.

In the future, children will be for the poor a resource, for the plutocrat a mode of ostentation, for the bureaucrat and small rentist a sacrifice.

The greatest tonics for will-power are truth and justice.

The greatest friends of Spain are those who have justly shown us the defects which go with our good qualities.

The weak succumb, not from weakness, but from ignoring that they are weak. It is the same with nations.

Physical pain is easily forgotten but a moral chagrin lasts indefinitely.

Libraries are successively the cradles and the sepulchres of the human mind.

The human brain is a world consisting of a number of explored continents and great stretches of unknown territory. Its vast potentialities are ignored and unsuspected by the commoner run of laymen. The cultivated man tries to discover its occult treasures.

Let the vicious and idle say what they choose, agreeable and useful work remains the best of distractions.

The ideal of science is to elucidate the dark mysteries and unknown forces which invest us, for the benefit of our descendants and to make the world more agreeable and intelligible, while we ourselves are forgotten, like the seed in the furrow.

Our period differs from other epochs in an exaggerated triumph of the practical, in the production of good laborers but poor directors.

Let us follow the wise in all humility that we may some day march in company with them or even ahead of them.

Nothing is so distracting to old men as to occupy themselves with history, in other words, with the lives and deeds of men more antique than themselves.

The desire for fame is of two kinds: to seek it as an end or to use it as a means.

In spite of the efficiency of modern medicine, our intellectual or intelligent people do not live as long as in antiquity.

The saddest thing about old age is that its future is behind it.

Like an earthquake, true senility announces itself by trembling and stammering.

It is notorious that the desire to live increases as life itself shortens.

A mature fat man excites pity, like a ship well stocked for its last voyage.

Since time slays us, our young people aim to kill time, not knowing the invincible nature of Chronos.

If death were like the consoling dreamless sleep depicted by ancient philosophers, we should desire it. But Freud has shown that sleep is a theatre of far more disconcerting action.

You amount to very little if your death is not desired by many persons.

How many sages, philosophers and even vulgar people have the pretence of dying like heroes, when they really die like actors!

In the pomp of a funeral, the only beings who seem to appreciate the solemnity of the occasion, and to abstain from gossiping about the defunct, are the horses.

ADDITIONAL SENTENCES FROM CHARLAS DE CAFÉ

(Translated by Col. George Blakely, U. S. Army (Ret.), San Francisco.)

Blessed are they who can say no, for they shall live in peace.

Let us treasure those judicious friends who know how to take the refusal of an unjustified claim.

Few bonds of friendship are so strong that they cannot be severed by a woman's hair.

Friendship dislikes poverty as the flower darkness. Therefore, if you would keep your friends, conceal your wants and troubles.

A person is not your friend who writes to you through a secretary, or, granting you an interview, passes it off with vulgarities and commonplaces. On the contrary, he esteems you who, in conversing with you, frames a happy remark, makes a timely observation, or gives you some good advice.

The man of culture would be lost in the blue, if the woman, like the ballast and cord of a captive balloon, did not prudently draw him back to earth.

Reality overruns every concise phrase, like liquid poured into a tiny cup

As long as our brain is a mystery, the universe, the reflection of the structure of the brain, will also be a mystery.

Many times I have wondered if evil is not put into the world as a motive for work and an incentive to our curiosity.

Described by the monkey, what would man be? Probably a sad case of degeneration, characterized by a contagious mania for talking and thinking.

Never could I understand how certain religious communities offer to God, by way of expiatory mortification, the brutifying action of silence. This is equivalent to abdicating our dignity as men, since the only essential feature which distinguishes us from the animals is the precious gift of articulate speech.

In conversation, let us check the insane temptation to scatter jokes at the expense of our friends. As Gracian said, "Put up with jests, but do not make them." In unsheathing its unvenomed sting, the bee usually gives itself a mortal wound. There is no greater enemy of an intellectual nature than ill-nature.

That which enters the mind through reason can be corrected. That which is admitted through faith, hardly ever.

It is idle to dispute with old men. Their opinions, like their cranial sutures, are ossified. Nothing inspires me with more astonishment and venerations than an old man who can change his opinions. It is only while the brain is growing that doctrines can be inculcated and errors corrected.

Let us look on men with systematized minds as on books; they are read if interesting, but no one argues with them.

To reason and convince—how difficult, long, and laborious! Suggestion—how easy, quick, and cheap!

Let us never argue with fanatics. For we are not contending with a man but with a formidable army, whose invisible soldiers, posted as a rear guard in space and time, cannot hear us.

Back of our opponent stand those who shaped his brain and his ideas, that is to say, his parents, his teachers, his friends, the social caste he belongs to, and in short the innumerable train of illustrious dead who are set against us by his dogmatic pride, his errors, and his interests.

Seldom indeed do we find confirmation of the common maxim: "from discussion issues *light*." What often issues is the *fire* of exasperated pride, *smoke* that obscures the clearest problems, and the *ashes* of disillusion. So, at the end, the contestants are rather burnt out than illuminated.

Only the doctor and the dramatist enjoy the rare privilege of charging us for the annoyance they give us.

A great dose of indulgence is required for affection to subsist. Let us deal with men as the alienist deals with his patients; to their manias and aggressions he always opposes a soothing charity and understanding.

Extravagances! Gross illusions! Who is free from them? The fact is, the peculiarities and follies of the superior man attract attention, while those of the insignificant man pass unnoticed by anyone.

Mediocre men, perhaps to console themselves, often ridicule the man of genius for extravagances and even for lunacies.

In general, sincere opinions are expressed only in small and intimate circles. With a theatre and gallery, we are all, to some extent, play-actors.

Besides other inconveniences, much talking has the very serious drawback of preventing an intimate acquaintance with the people with whom we converse. Our loose flow of words converts them into listening enigmas. The tyrants of monologue unconsciously prepare for themselves great and unpleasant surprises.

Zoology is often very instructive. It is well known how extraordinary is the longevity of the crocodile and the elephant, animals of thick and almost impenetrable hide. From this we may infer that to attain long life, we should sheathe our spiritual skin, making it insensible to the pin-pricks of rivals, of enemies and of the envious.

Glory is nothing more than oblivion postponed.

No one has expressed more vigorously and eloquently his contempt for glory, than Tolstoi (see his intimate diary), and yet the great Slavic writer spent his life in writing novels, that is to say, in courting with solicitude the applause of his contemporaries and of posterity.

Only those men merit glory who by intelligent and unselfish action embellish, improve, and enlighten the world we live in.

Small inward treasure does he possess who, to feel alive, needs every hour the tumult of the street, the emotion of the theatre and the small-talk of society. Hence the urgency of adorning the abode of the spirit carefully and betimes. Then, if the world rejects or wearies us, we may build a dream-castle within ourselves.

Grandmontaigne writes that he knew a German naturalist who undertook a voyage to Brazil to hunt a butterfly. I met a scientist in New York—Doctor Forel—who went to America solely to study an ant. Happy the nations in which men are born who risk their ease and even their lives—a glorious and noble life—to examine a lowly form of life far away.

The best book is just that which circumstances and social environment prevent being written. What an admirable and most original library our country would possess, in philosophy as well as in literature, could it gather the books our classic talent, and even our contemporaneous talent, did not dare launch into publicity!

I hold it probable that one of the reasons (there are many) why the mind of certain animal species has remained stationary lies in the ignorance of death, or in having but a confused and crepuscular consciousness of it. Emerging precociously in primitive man, the terror of non-existence has been the major instrument of his progress. It has fashioned the hand and complicated the brain, and has produced those admirable tools of defense, of exploration, and of work, which, acccording to Bergson, are the characteristics of rationality.

Schopenhauer says: "The old man walks about tremulously or reposes in a corner, being but the shadow or ghost of his former self. When death comes, what remains but to die?"

Much remains—a brain tenaciously grappling with its functions of thinking, although it feels itself blocked by weak and failing organs. And the brain is the whole man.

A certain philosopher affirmed that with man's death "all is reduced to a broken mirror." Taken altogether, the most deplorable thing is not the fracture of the mirror but its rapid deterioration when it has hardly arrived at reflecting but an insignificant phenomenal sector of the Cosmos. From the height of eternity, human heads must seem to the psychological Principle of the Universe like those bubbles of foam formed by the wave that breaks along the shore. They glisten for a moment with polychromic light, reproduce in miniature the azure of the sky and the magic of the landscape, then in an instant burst, giving way to a new generation of irridescent globules.

I was always inclined to look on dancing as a kind of grotesque gymnastics, with no more purpose than to facilitate the circulation of the blood and to develop the lungs, or else as a provocative game left over from barbarous ages, calculated to awaken the sensuality of the man deadened by the fatigues of labor.

To-day, I think that every habit refractory to the action of time must possess some positive advantage for the species. So I have ended by correcting my old opinion.

Two classes of beauty are universally recognized—the static and the dynamic. At receptions and in the theater, the marriageable girl exhibits by preference her statuesque beauty, interpreted by line and color. But only when she dances does she reveal fully her dynamic beauty, that is to say, grace, agility, and easy carriage. With face aglow and eyes sparkling with emotion, every dancing maiden seems to be telling her partner: "Look at me; I am more than a beautiful statue; I have also the sense of rhythm and music. My lungs are tireless, my joints supple and firm, and in my breast beats a heart proof against fatigue and emotions. Take me, for I am sound and strong; I am not intimidated, rather am I imperiously attracted by the pains and sacrifices of motherhood."

I wonder at the intrepid and sublime unconsciousness with which woman pursues matrimony, where often await her, along with maternal anxiety, disillusion of love, physical ugliness, and not infrequently infirmity and premature death.

"All inclines towards death," is affirmed by Hartman and Mayland. Science teaches that the world tends to lose its differences of potential. Entropy (Clausius), ever-increasing, will put an end to all phenomena, including of course vital phenomena. If such is the destiny of life, I understand cosmic suicide and I find natural and almost desirable the shock of the dark star, which, as Arrhenius predicts, will return our poor old planet to its primordial nebulous state. With mortal anguish I call to mind the disconsolate *Debemur morti nos nostraque* of Horace. To what end should we labor?

Thus caviling I look out of the window. It is Sunday in Madrid. A torrent of jocund life is pouring through the street, branching into a thousand winding rivulets. Handsome women are on their way to the theater; young sales-clerks are storming the coaches for the Bull Ring; countless couples and families crowd together, eagerly awaiting the street-cars of La Bombilla, of La Moncloa, or of Los Cuatros Caminos. And in the presence of this unconquerable optimism of life I react. Let us obey its mandates. To display such optimism, must not life have reasons unknown to the philosopher and the scientist?

The law of compensating counteraction holds for peoples as well as for individuals. Docile and disciplined Germany has ever been the cradle of great religious, philosophical, and political revolutions; while Spain, a ferociously individualistic and undisciplined nation, has been a never-

failing seed-plant of compliant minions and submissive flatterers of the church, of royalty, and of plutocracy.

Harsh experience, disappointments, wrongs, it has often been said, are wont to ruin our mental health. The brain, sublime gift of life and seat of prudence and sanity, becomes a kind of odious parasite affecting the whole organism, recalling, with what seems like insistent glee, our lapses and failures. "If one could only forget," said Themistocles to a rhetorician, who had promised him a treatise on mnemonics. But Ptolemy's precious secret of the lotus has been lost forever. Ah! if science could but succeed in narcotizing mental obsessions of this kind! Could some savant only find an alkaloid to abolish the evocation of torturing thoughts without abolishing the integrity of the machine! But the artificial paradises sung by Baudelaire, DeQuincy and Verlaine are not refuges but torments.

Excessive corpulence, the index of good nature and deliberation in the man, is commonly a guarantee of fidelity in the woman. Aside from the shameless artistic error involved in exhibiting a monstrous figure, the heart of the rotund matron has enough to do in irrigating some hundredweights of adipose tissue.

Philosophers and theologians discourse with great subtlety on the origin of evil. Without taking flight into metaphysics or losing sleep over the attempt to reconcile antinomies, it seems beyond dispute that the proximate cause of evil is the inexorable necessity of nourishing and promoting our own vitality at the expense of other lives, high and low. One might affirm that the fashioning principle of the organic world, having opened out bewildering perspectives of progress by releasing the cell from the cul de sac of the plant, ordained for primordial animal protoplasm the cruel law of sacrifice of vegetable protoplasm. Then followed the immolation of animal by animal and of man by man.

F. H. GARRISON.